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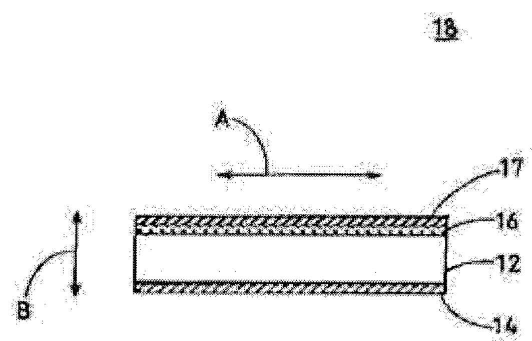
## (54) SOLID ELECTROLYTE FUEL CELL AND UNIT CELL USED TO ITS FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce the resistance of a solid electrolyte plate in the peripheral direction, and to improve the conductivity in the surface direction, by applying a coat of the material having the conductivity higher than the conductivity of the material of the air electrode, on the surface of each unit cell, in a solid electrolyte fuel cell of a laminated structure.
SOLUTION: In this solid electrolyte fuel cell, plural unit cells 18 are provided in the laminated form through separators. A unit cell 18 consists of four layers structure of a solid electrolyte plate 12, a fuel electrode 14, an air electrode 16, and a conductive function membrane 14. The air electrode 16 is formed of a lanthanum manganite system material or the like, and the conductive function membrane 17 at the upper side is formed of a lanthanum cobaltite system material or the like having the conductivity higher than the conductivity of the material of the air electrode. The thicknesses of the layers are preferable to make the solid electrolyte plate 12 about 300μm, and the fuel electrode 14, the air electrode 16, and the conductive function membrane 17, all 50μm. Consequently, the freedom of the material design is made wider.



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**CLAIMS**

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[Claim(s)]
[Claim 1]In a solid oxide fuel cell in which a cell with which a fuel electrode is provided in one side of a solid electrolyte plate, and an air pole is provided in an opposite side makes a laminated structure, A solid oxide fuel cell to which a tunic is given to the surface of an air pole of each cell concerned, and the tunic concerned is characterized by being the material which has conductivity higher than conductivity of material of said air pole.
[Claim 2]The solid oxide fuel cell according to claim 1, wherein an air pole of each of said cell is formed with material of a lantern manganite system and a tunic of the air pole concerned is formed with material of a lantern KOBARU tight system.
[Claim 3]In a cell with which it is a cell used for a solid oxide fuel cell, and a fuel electrode is provided in one side of a solid electrolyte plate, and an air pole is provided in an opposite side, A cell with which a tunic is given to the surface of an air pole of each cell concerned, and the tunic concerned is characterized by being the material which has conductivity higher than conductivity of material of said air pole.
[Claim 4]The cell according to claim 3, wherein it is a cell used for a solid oxide fuel cell, an air pole of each of said cell is formed with material of a lantern manganite system and a tunic of the air pole concerned is formed with material of a lantern KOBARU tight system.

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[Translation done.]

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention]The cell with which a fuel electrode is provided in one side of a solid electrolyte plate, and an air pole is provided in an opposite side this invention about the cell used for the solid oxide fuel cell (SOFC) and it which make a laminated structure, It is related with the improvement art of the characteristic of the air pole of the cell in a solid oxide fuel cell in more detail.
[0002]
[Description of the Prior Art]As a fuel cell, a phosphoric acid type, a melting carbonate type, a solid oxide type, etc. are known by the electrolytic kind better than before. The solid material which has ion conductivity instead of liquid material like a phosphoric acid aqueous solution or melting carbonate is used for a solid oxide fuel cell (SOFC) as an electrolyte in it.
[0003]And since this solid oxide fuel cell (SOFC) has good generation efficiency compared with other fuel cells, such as a phosphoric acid type and a melting carbonate type, and its exhaust heat temperature is also high, I hear that it can build the power generation system in which efficient use is possible, and it is capturing the spotlight especially in recent years.
[0004]As the gestalt, it is roughly classified into a monotonous type thing and a cylindrical thing. Among those, the cell of the solid oxide fuel cell (SOFC) of the conventional self-supported film monotonous type classified into a monotonous type thing has a three-tiered structure which coated both sides of the electrolyte plate with the thin film of the air pole and the fuel electrode.
[0005]This conventional solid oxide fuel cell (SOFC) is shown in JP,H7-6774,A. This is explained with reference to the structure of the cell of the self-supported film monotonous type solid oxide fuel cell (SOFC) shown in drawing 5. The cell 9 shown in the figure has sandwiched the solid electrolyte plate 7 between the air poles 6 which the fuel electrode 8 in which fuel gas touches, and air touch.
[0006]It comes to provide many single cells of the structure which formed the separator which does not illustrate a self-supported film monotonous type solid oxide fuel cell (SOFC) on the outside of the fuel electrode 8, and the outside of the air pole 6, respectively in laminate shape over a layer. And in the solid oxide fuel cell (SOFC) constituted in this way, fuel gas (hydrogen, carbon monoxide) contacts the fuel electrode 8, and oxidizing gas (air or oxygen) contacts the air pole 6. And the oxygen ion ($O^{2-}$) generated by the air pole 6 moves an electrolyte, the fuel electrode 8 is reached, and in the fuel electrode 8, $O^{2-}$ reacts to hydrogen ($H_2$), and emits electrons. Thereby, the electrical and electric equipment is made and an electric flow arises.
[0007]In this solid oxide fuel cell (SOFC), the air pole 6, the electrolyte plate 7, the fuel electrode 8, each electrical property, especially conductivity influence the performance of a cell greatly. The electrolyte plate 7 is formed of zirconia.
In order to hold sufficient intensity, the thickness is about 300 micrometers.
The air pole 6 is formed with the material of a lantern manganite system.
The thickness is about 50 micrometers from the necessity of making gas penetrating.
The fuel electrode 8 is formed with the nickel-YSZ (nickel yttria stabilized zirconia) cermet material.
The thickness is about 50 micrometers from the necessity of making gas penetrating, like the air pole 6.

[0008]By the way, in the solid oxide fuel cell (SOFC) of the conventional self-supported film monotonous type, when that size was small enough, only resistance of the direction (the direction shown in the arrow D of drawing 5 and the following consider it as the perpendicular direction D) vertical to the field of the electrolyte plate 7 was a problem, but this resistance is comparatively low. Therefore, the conductivity of materials other than an electrolyte material does not influence battery capacity greatly.
[0009]
[Problem(s) to be Solved by the Invention]However, if a cell is enlarged, current will flow also in the direction (the direction shown in the arrow C of drawing 5 and the following consider it as the plane direction C) parallel to the field of the electrolyte plate 7, and resistance of the direction shown in the plane direction C will influence battery capacity greatly. Specifically, the conductivity of nickel-YSZ of the fuel electrode 8 has the conductivity of the lantern manganite of the air pole 6 as low as about 20 S/cm to being about 200 S/cm. That is, resistance of the membrane part of the material of the air pole 6 had caused the fall of the battery capacity accompanying enlargement of a cell owing to.
[0010]Then, although I hear that thinking makes material of the air pole 6 things other than the thing of a lantern manganite system and there is, in other compounds, there are problems, such as reactivity with zirconia and disagreement of a coefficient of thermal expansion, and application is difficult. That is, the material of the air pole 6 has the optimal thing of a lantern manganite system, therefore there is a limit in improvement in the conductivity of the air pole 6.
[0011]The issue which is going to solve this invention, without changing the construction material of the air pole in connection with an electrode reaction, Resistance of the plane direction of a solid electrolyte plate is reduced, and it is in providing the cell used for the highly efficient self-supported film monotonous type solid oxide fuel cell (SOFC) and it which can raise the conductivity of a plane direction.
[0012]
[Means for Solving the Problem]In order to solve this SUBJECT, a solid oxide fuel cell of this invention, one side of a solid electrolyte plate -- a fuel electrode -- in a solid oxide fuel cell which makes a laminated structure, a tunic is given to the surface of an air pole of each cell, and a cell with which an air pole is provided in an opposite side makes it a gist for the tunic concerned

to be the material which has conductivity higher than conductivity of material of said air pole.
[0013]In that case, it is desirable to reduce resistance of a plane direction of an electrolyte plate etc., when it obtains desired battery capacity that an air pole of each of said cell is formed with material of a lantern manganite system, and a tunic of the air pole concerned is formed with material of a lantern KOBARU tight system.
[0014]A cell used for a solid oxide fuel cell of this invention, one side of a solid electrolyte plate -- a fuel electrode -- in a cell with which an air pole is provided in an opposite side, a tunic is given to the surface of an air pole of each cell concerned, and the tunic concerned makes it a gist to be the material which has conductivity higher than conductivity of material of said air pole.

[0015]In that case, when that an air pole of each of said cell is formed with material of a lantern manganite system, and a tunic of the air pole concerned is formed with material of a lantern KOBARU tight system reduces contact resistance at the time of laminating the cell concerned to two or more series, it is desirable.
[0016]
[Embodiment of the Invention]Hereafter, the suitable embodiment of this invention is described in detail with reference to Drawings. Drawing 1 shows the structure of the solid oxide fuel cell (SOFC) 10. As shown in the figure, the solid oxide fuel cell (SOFC) 10 is formed in laminate shape via two or more cells 18, the separator 20 according [ 18 -- ] to the charge of a lanthanum chromite system ceramic material, and 20 --.
[0017]As for the separator 20 interposed between each of this cell 18, the insertion holes 28a and 28c of a fuel gas pipe and the insertion holes 28b and 28d of the air pipe are established in the four-corners corner of that main part by the physical relationship of the diagonal line, respectively. With this figure, the separator 20 shows the air pole 16 of the cell 18, and the field of the side which counters.
[0018]The air inlet which introduces the air which is open for free passage to the insertion holes 28b and 28d of an air pipe, and is supplied through the air pipe so that the air pole 16 of the cell 18 may be touched, and the air outlet which makes the air introduced into the air pole 16 discharge are provided, respectively. And between an air inlet and an air outlet, the airstream way slot 26 of many numbers and 26 -- are provided as mentioned above, while the air introduced from the air pipe by this to the air inlet flows through those airstream way slots 26, the air pole 16 of the cell 18 is contacted, and it is discharged from an air pipe through an air outlet.
[0019]Also to the fuel electrode 14 by the side of [ 18 ] the rear face of this separator 20 (i.e., a cell) and the field of the side which counters. The fuel gas inlet which introduces the fuel gas supplied through a fuel gas pipe like the opposed face of this air pole 16 so that the fuel electrode 14 of the cell 18 may be touched, and the fuel gas outlet which makes the fuel gas introduced into that fuel electrode 14 discharge are provided.
[0020]And a fuel gas flow route slot is too provided as mentioned above also between the fuel gas inlet of this separator 20, and a fuel gas outlet. While the fuel gas introduced to the fuel gas inlet flows through this fuel gas flow route slot, the fuel electrode 14 of the cell 18 is touched, and it is discharged from a fuel gas pipe through a fuel gas outlet.
[0021]The power generation mechanism of this solid oxide fuel cell (SOFC) 10 is as follows. Namely, when the air which flows through the airstream way slot 26 of the separator 20 contacts the air pole 16 of the cell 18, oxygen ion ($O^{2-}$) is generated by the air pole 16. This oxygen ion ($O^{2-}$) moves the solid electrolyte plate 12, and reach the fuel electrode 14 of an opposite side face, and in the fuel electrode 14 side. After all, since fuel gas is flowing through the fuel gas flow route slot of the separator 20, the oxygen ion ($O^{2-}$) which has moved from the air pole 16 side reacts to hydrogen ($H_2$) in the fuel gas, it becomes a steam ($H_2O$), and electrons are emitted, and thereby, a power generation state is acquired.
[0022]Next, with reference to the section structure figure of the solid electrolyte plate of the solid oxide fuel cell (SOFC) of the self-supported film monotonous type of drawing 2, the structure of the cell 18 is explained in full detail. As shown in the figure, in the cell 18 of this solid oxide fuel cell (SOFC) 10. For example, the fuel electrode 14 by a nickel-YSZ (nickel yttria stabilized zirconia) cermet material is formed in one side of the solid electrolyte plate 12 by yttria stabilized zirconia or the charge of a scandia-stabilized-zirconia system ceramic material.
[0023]The air pole 16 by lantern manganite material is formed in an opposite side face, and the electric conduction functionality thin film 17 by lantern KOBARU tight material is formed in the air pole 16 upper part. That is, the cell 18 comprises four layer systems of the solid electrolyte plate 12, the fuel electrode 14, the air pole 16, and the electric conduction functionality thin film 17. As for each layer thickness, in the solid electrolyte 12, about 300 micrometers, the fuel electrode 14, the air pole 16, and the electric conduction functionality thin film 17 are all about 50 micrometers.
[0024]1. Explain the electric conduction characteristic about the electric conduction characteristic next. The conductivity of the lantern manganite material of the air pole 16 is 20 S/cm, and the conductivity of the lantern KOBARU tight material of the electric conduction functionality thin film 17 is 100 or more S/cm. That is, the conductivity of the electric conduction functionality thin film 17 is very higher than the conductivity of the air pole 16.
[0025]Therefore, rather than the conventional cell 9 which the cell 18 concerning this invention shows to drawing 5, even if about 50 micrometers and the thickness of those become thick, there is almost no influence of the resistance on the perpendicular direction B of the cell 18 shown in drawing 2 (the thickness of about 450 micrometers and the cell 9 of the thickness of the cell 18 is about 400 micrometers).
[0026]Since the conductivity of the electric conduction functionality thin film 17 is very higher than the conductivity of the air pole 16, the resistance of the plane direction A of the cell 18 is reduced compared with the conventional cell 9.
[0027]Here, with reference to the coating thickness of the lantern KOBARU tightness of drawing 3, and the relation of battery resistance, it explains further. In the figure, a horizontal axis shows the thickness of coating of lantern KOBARU tightness, and the vertical axis shows the resistance of the cell 18. More specifically, the trial calculation of resistance of the plane direction A of the cell 18 and the perpendicular direction B is made about the separator 20 of 5 cm x 5-cm size with the flute width of 3 mm.

[0028]As shown in this figure, the resistance of the perpendicular direction B is constant irrespective of the thickness of lantern KOBARU tightness (conductive functional membrane 17). On the other hand, it is decreasing as the thickness of resistance of the plane direction A of lantern KOBARU tightness (electric conduction functionality thin film 17) increases. then, if lantern KOBARU tightness (electric conduction functionality thin film 17) is coated with a thickness of about 50 micrometers, the resistance of the plane direction A can decrease in the minute half [ about ] only in the case of the air layer 16 (the figure lantern KOBARU resistance whose tight coating thickness is 0).
[0029]Drawing 4 uses 11ScSZ as an electrolyte plate, and the size of the polar zone in the conditions which set the operating

temperature as 1000 ** shows the final power generation result of the solid oxide fuel cell (SOFC) of 5 cm x 5-cm size. As shown in the figure, although the maximum output was 16W, when the solid oxide fuel cell (SOFC) of the conventional three-tiered structure coated lantern KOBARU tightness as the electric conduction functionality thin film 17 and made it four layer systems, the maximum output became more than 33W.
[0030]Thus, if the electric conduction functionality thin film 17 is coated, material resistance of a contact surface will become low. Therefore, even if it laminates the cell 18 to two or more series, the fall of battery capacity can be prevented. it becomes possible to boil the battery capacity itself markedly and to make it improve compared with the conventional thing.
[0031]2. Add [ characteristics / next / other ] explanation about points other than the electric conduction characteristic. Lantern KOBARU tightness is an inharmonious point of reactivity with zirconia, or a coefficient of thermal expansion, and is inferior to lantern manganite. However, in the solid oxide fuel cell (SOFC) 10 in this invention, the electric conduction functionality thin film 17 which comprises lantern KOBARU tight material produces problems, such as a reaction with the solid electrolyte plate 12, in order to share only an electric conduction function.
[0032]That is, since the conductivity of the air pole 16 stops influencing battery capacity, the flexibility (material composition, thickness, porosity, etc.) of the materials design of the air pole 16 spreads.
[0033]Changes various in the range which is not limited to the above-mentioned embodiment at all, and does not deviate from the meaning of this invention are possible for this invention. For example, generally, although few things of the porosity of the air pole 16 are desirable, since the conductivity of the air pole 16 stops influencing battery capacity by using lantern KOBARU tightness as the electric conduction functionality thin film 17, when carrying out a materials design, the porosity of the air pole 16 may become a little large.
[0034]
[Effect of the Invention]A tunic is given to the surface of the air pole of each cell, and since the tunic concerned is the material which has conductivity higher than the conductivity of the material of said air pole, the solid oxide fuel cell (SOFC) of this invention can reduce resistance of the plane direction of an electrolyte plate. Therefore, the fall of the battery capacity accompanying enlargement of a cell can be prevented.
[0035]Since the air pole of each cell of a solid oxide fuel cell (SOFC) is formed with the material of a lantern manganite system and the tunic of the air pole is formed with the material of a lantern KOBARU tight system, Since the conductivity of an air pole stops influencing battery capacity, the flexibility (material plasticity, thickness, porosity, etc.) of the materials design of an air pole becomes large.
[0036]The cell used for a solid oxide fuel cell (SOFC), A tunic is given to the surface of the air pole, and since the tunic concerned is the material (lantern KOBARU tightness) which has conductivity higher than the conductivity of the material (lantern manganite) of said air pole, material resistance of the contact surface at the time of laminating to two or more series, i.e., contact resistance, can be reduced.

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[Translation done.]

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1]It is a perspective view showing the laminated structure of the self-supported film monotonous type solid oxide fuel cell (SOFC) concerning one embodiment of this invention.
[Drawing 2]It is a section structure figure of the solid electrolyte plate of the self-supported film monotonous type solid oxide fuel cell (SOFC) shown in drawing 1.
[Drawing 3]It is a figure showing the relation between the coating thickness of lantern KOBARU tightness, and resistance of the cell 18.
[Drawing 4]It is a figure showing the power generation performance of the conventional three-tiered structure cell and 4 layer system cells concerning one embodiment of this invention.
[Drawing 5]It is a section structure figure of the solid electrolyte plate of the solid oxide fuel cell (SOFC) of the conventional self-supported film monotonous type.
[Description of Notations]
10 Solid oxide fuel cell (SOFC)
12 Solid electrolyte plate
14 Fuel electrode
16 Air pole
17 Electric conduction functionality thin film
18 Cell
20 Separator

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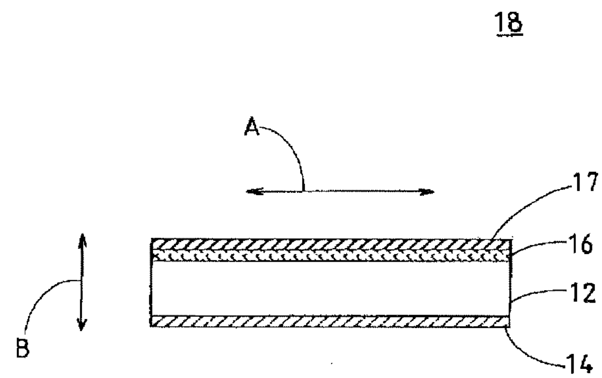
# (54)【発明の名称】　固体電解質型燃料電池及びそれに用いられる単電池

(57)【要約】

【課題】　電極反応に関わる空気極の材質を変更することなく、固体電解質板の面方向の抵抗を低減し、面方向の導電率を向上させることが可能な高性能な自立膜平板型の固体電解質型燃料電池（ＳＯＦＣ）及びそれに用いられる単電池を提供すること。

【解決手段】　単電池１８を、固体電解質板１２、燃料極１４、空気極１６及び導電機能性薄膜１７の４層構造にすることによって、より高い導電特性をえる。この場合、導電機能性薄膜１７の材料としては、空気極１６の材料よりも、導電率の高いものを適用する。



る４層構造電池の発電性能を示す図である。

【図５】従来の自立膜平板型の固体電解質型燃料電池（ＳＯＦＣ）の固体電解質板の断面構造図である。

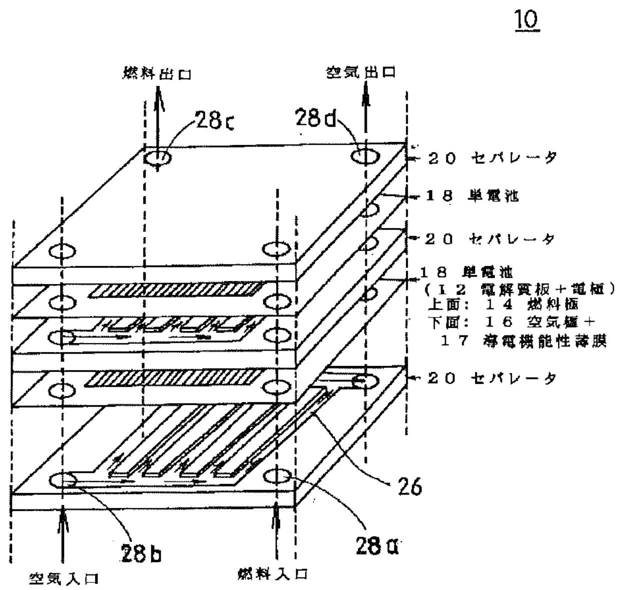
【符号の説明】

１０　固体電解質型燃料電池（ＳＯＦＣ）
１２　固体電解質板　＊

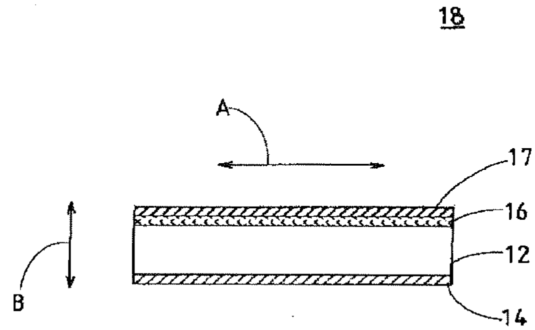


＊１４　燃料極
１６　空気極
１７　導電機能性薄膜
１８　単電池
２０　セパレータ

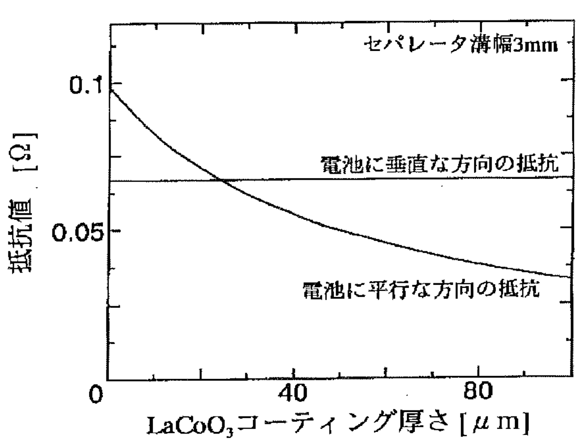
【図１】



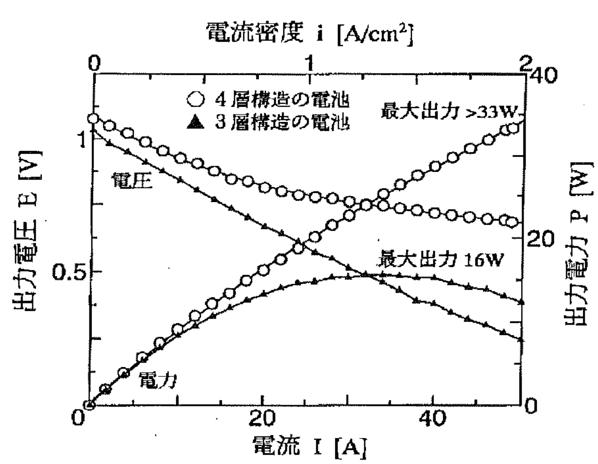

【図２】




【図３】




【図４】



【図５】